Dear Customer,

An in-flight interruption is not a regular event. None the less, as airlines strive to further optimize aircraft utilisation and minimize costs, it is inevitable that the effect of such event will become more significant for any given operation.

Herein you will find briefings on the most significant opportunities currently available to minimize in-flight interruptions. The aim is to share A320 Family fleet experience between all operators.

This FAST Special provides an analysis of in-flight interruptions recorded for the A320 Family fleet over the last 4 years. The main contributors have been identified and consequently proposals defined that may allow your airline to further reduce its in-flight interruption rate.

The proposals range from relatively simple enhancements that are easy to implement to those that are more complex, consequently requiring more time and effort to introduce. However, all are effective means of reducing in-flight interruptions and in addition offer the possibility to further enhance operational efficiency.

Information is provided to allow the benefits applicable to your organisation to be easily identified. We now invite you to consider each proposal in the context of your fleet and its operation. Should you need further information to support you, please feel free to contact us.

Antoine **Vieillard**
Vice President A320 Family Programme
Customer Services

FAST

AIRBUS TECHNICAL MAGAZINE

FLIGHT
AIRWORTHINESS
SUPPORT
TECHNOLOGY

M A Y 2 0 0 5

A320 Family

A practical guide to reducing in-flight interruptions

Publisher: Bruno Piquet
Editor: Kenneth Johnson
Graphic Designer: Agnès Massol-Lacombe

Customer Services Marketing
Tel: +33 (0)5 61 93 43 88
Fax: +33 (0)5 61 93 47 73
E-mail: fast.magazine@airbus.com
Printer Escourbiac

FAST may be read on Internet http://www.airbus.com/customer/fast/asp under Customer Services/Publications

ISSN 1293-5476

Airbus Customer Services

Photographs by Hervé Bérenger, Hervé Goussé and Philippe Masclet

This issue of FAST has been printed on paper produced without using chlorine, to reduce waste and help conserve natural resources.
Every little helps!

Overall analysis

It is essential to minimise the delays and cancellations that accompany the operation of commercial aircraft. Airbus continues to develop and deliver efficient, proven solutions to reduce technical delays and cancellations for every aircraft in the A320 Family fleet.

An in-flight interruption such as a turn-back or diversion places the aircraft, it's passengers, freight and crew in the wrong place and in need of maintenance crew attention. Furthermore, these events can have a major impact throughout schedules. The trend for A320 Family in-flight interruptions is steadily declining and today the in-service fleet experiences an in-flight interruption for technical reasons about once every 7000 flights.

To ensure that all operators of A320 Family aircraft are briefed on the opportunities for minimising in-flight interruptions within their operation, Airbus Customer Services has produced this FAST Special. It aims to share fleet-wide experience with all operators.
To do this it focuses on the principle root causes of in-flight interruptions and consequently identifies proposals that are widely applicable and that have demonstrated their value in reducing not only minimizing in-flight interruptions but also in reducing delays and cancellations.

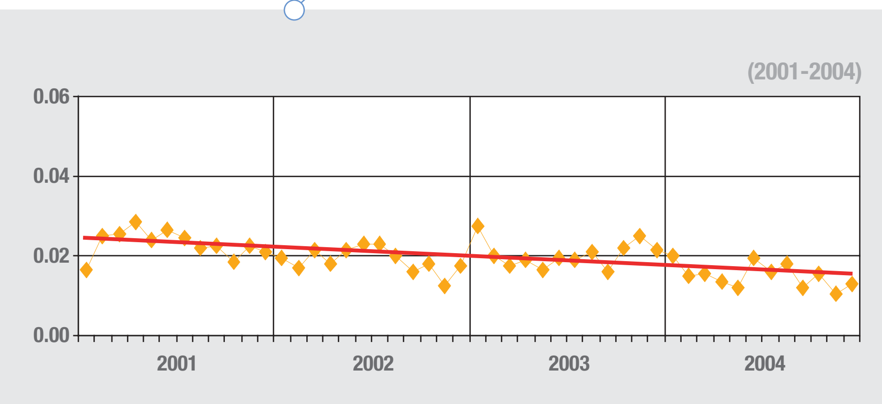
Most passengers, even frequent flyers, have never experienced an in-flight interruption, such as an In Flight Turn Back (IFTB) or a diversion (DV). They are very rare. Nevertheless, airline Fleet Managers know that there is a need to consider technical delay reduction and in-flight interruption event limitation when looking at aircraft or procedures enhancements.

Global analysis of in-flight interruptions for the A320 Family shows that there has been a steadily improving trend in the rate over the last few years.

In-flight interruptions typically follow specific warnings to the pilot indicating:

- Landing gear 'retracted and uplocked' not confirmed electrically
- Excessive cabin altitude warning
- Flight control surface not responding
- Engine shutdown following excessive vibration or exhaust gas temperature
- Hydraulic low level warning due to leakage
- Smoke warning

A320 world fleet
In-flight interruptions rate per 100 revenue takeoffs



The cost of an in-flight interruption can vary significantly from one operation to another. Costs are greatly influenced by the nature of the event and the support available at the aircraft's location.

The immediate operational impact of an in-flight interruption could be:

- Flying to a runway long enough to accept the aircraft (in cases such as flap locks)
- 'Overweight' landing
- 'Single engine' landing following an in-flight engine shutdown
- Passenger discomfort in the case of excessive cabin altitude

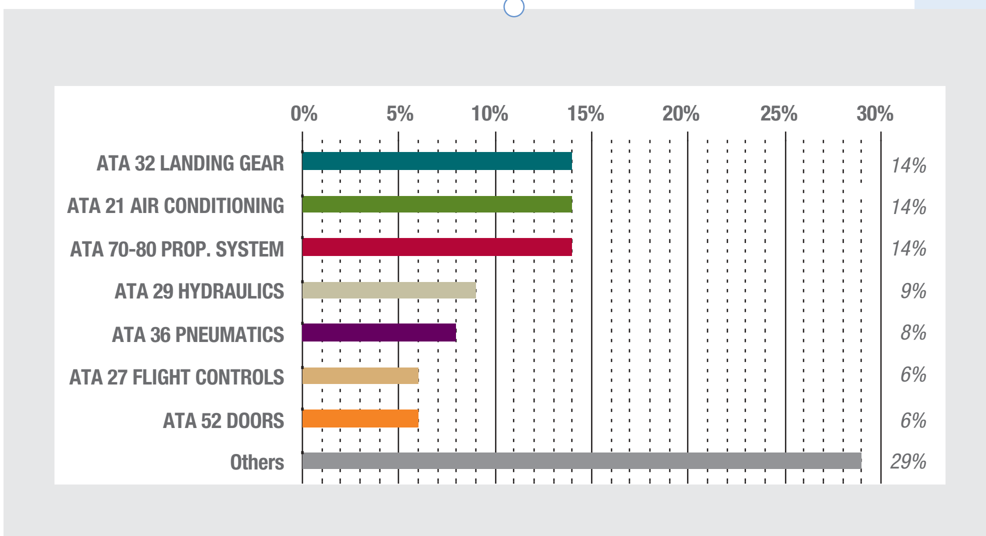
Further consequences could be:

- Men and materials sent to the diverted aircraft to repair it and/or ferry it back to base
- Cancellation of following flights for the aircraft.
- Lack of spares leading to an AOG situation
- Passengers booked onto another flight and/or hotel, meal and compensation costs
- Aircraft, baggage, and freight checked by the emergency services (following smoke warning, for example)
- Other aircraft and crews rescheduled at short notice
- Flight Crew replacement (due to maximum flying hours regulations)
- The aircraft out of service for a lengthy period (replacement to be sourced)

By attributing the in-flight interruption events shown in the chart below to their appropriate ATA chapters the ATA drivers are identified. That is, the ATA chapters against which the majority of root causes have been attributed. For each ATA chapter a specific section in this FAST Special has been produced. Each of these sections presents a further breakdown of the events and based on this, proposals are made that will allow in-flight interruptions to be minimized. It should be noted that not all proposals are applicable to all aircraft in the fleet, but information to allow the applicability to be determined has been provided in all cases.

The issues causing in-flight interruptions can equally result in delays at the departure gate. Therefore, when considering the added value the proposals made in this FAST Special will bring to a given operation, the benefit effects should be considered not only in the context of minimizing in-flight interruptions but in overall operational efficiency.

In-flight turnbacks for year 2004
% contribution pere ATA



The data collection process starts with a Pilot Report which will lead the operator to raise an Air Safety Report (or equivalent) that must be sent to its airworthiness authority. Airbus either collects a copy of this ASR, receives the details in the airline's monthly reliability report, or more frequently, receives the contents of the reliability report plus the incident report text in electronic format and this is then loaded directly into the Airbus database in Toulouse using the following definitions:

- **Definition of In-Flight Turn-Back (IFTB):**
  The return of an aircraft to the airport of origin as a result of the malfunction or suspected malfunction of any item on the aircraft (Note: also called Airturnback).
- **Definition of Flight Diversion (DV):**
  The landing of an aircraft at an airport other than the airport of origin or destination as a result of the malfunction or suspected malfunction of any item on the aircraft.

Throughout this document the term **'in-flight interruption'** is used when describing either an IFTB or DV.

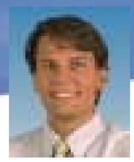
Airbus computes:
Flight interruption rate per 100 revenue takeoffs as (IFTB+DV)* 100/revenue take offs.

ATA 21 - AIR CONDITIONING

ATA 21

Air conditioning

François Gheur
Environmental Control System
Customer Services Engineering

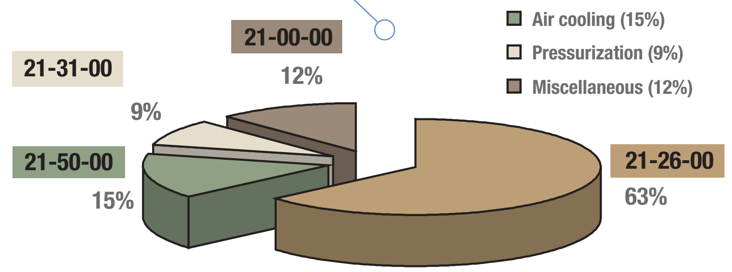


Between 2001 and 2004, 14% of in-flight interruptions have been attributed to ATA 21 chapter, environmental control system. They can be further divided as shown in the pie chart to the right.

The main reason for in-flight interruptions linked to the environmental control system is the inability to pressurise the aircraft. The avionics equipment ventilation computer can cause inability to pressurise by leaving the vent skin air valves open. This is addressed by proposal 1. Another cause of pressurisation problems is major leaks at pack level. Two pack components have been reinforced in that respect. These are proposals 2 and 3.

Miscellaneous events (21-00-00) are mainly smell or smoke reports with various origins not linked to the air conditioning. For example, an oil smell due to an APU oil leak will be logged under ATA 21 as a first step instead of ATA 49.

ATA 21 Distribution



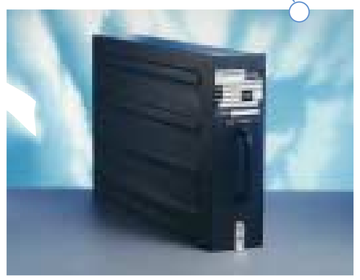
Proposal 1
ATA 21-26-00
ENHANCED AEVC

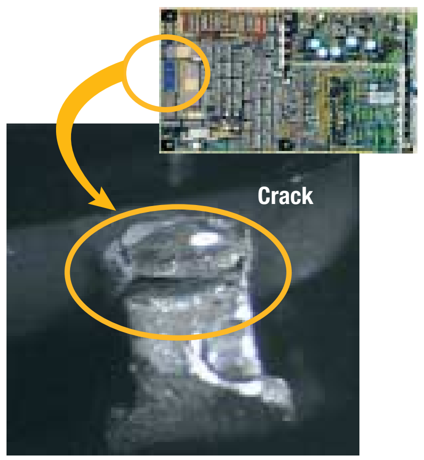
The latest Avionics Equipment Ventilation Computer (AEVC) standard clears two major issues. It can now deal with disruption of the electrical signals from the skin air valves, which previously caused AEVC and skin air valve faults, which could result in an in-flight interruption. This new controller also prevents spurious avionics smoke warnings in flight triggered by a pin crack at the level of the Random Access Memory module. With this latest AEVC standard, shock absorption has also been improved and the smoke detector test inhibited in flight.

\+ Resolves large portion of intermittent system failures. Improves dispatch reliability

\- None

AEVC and circuit board





Proposal 2
ATA 21-50-00
PACK BELLOWS

Rupture of clamps has caused pack bellows to break open, leading to cabin pressurisation difficulties. Replacing these clamps by corrosion-resistant and welded ones will minimize such occurrences.

Example of a failed clamp

\+ Cheap - Quick - Easy

\- None

Proposal 3
ATA 21-50-00
CONDENSER

Some pressurisation difficulties have been linked to rupture of the condenser (see example of ruptured condenser below) of one air conditioning pack. The affected pack will then no longer supply air to the cabin due to the significant leak at the rupture. The solution has been to increase the thickness of the wall that exhibited this failure mode.

Example of a ruptured condenser

\+ Cheap modification

\- Weight increase: approx. 250gr/unit

Contact

François Gheur
Environmental Control System
Customer Services Engineering
Tel: +33 (0)5 61 93 44 67
Fax : +33 (0)5 61 93 44 38
francois.gheur@airbus.com

Documentation

Proposal 1
ATA 21-26-00 **ENHANCED AEVC**

New AEVC PN 87292325V06

VSB 87292325-21-008
Rev. 02 24-Jul-02
- *AIR CONDITIONING*
  AVIONICS EQUIPMENT VENTILATION COMPUTER 87292325 – IMPROVEMENT OF THE AEVC ADAPTATION TO ALL VALVES AND FANS, IMPROVEMENT OF TRANSPARENCY TIME (STANDARD V05)

Modification 31678
Embodiment Rank MSN 1856

VSB 87292325-21-011
Rev. 00 05-Apr-04
- AIR CONDITIONING
  AVIONICS EQUIPMENT VENTILATION COMPUTER 87292325 – REDUCTION OF SMOKE WARNINGS (STANDARD V06)

Modifications 33967
Embodiment Rank MSN 2290

SB 21-1147 Rev. 00 05-Apr-04
- *AIR CONDITIONING*
  AVIONICS EQUIPMENT VENTILATION – INSTALL THALES AEVC STANDARD V06

TFUs 21.26.00.019 and 21.26.00.020

Proposal 2
ATA 21-50-00 - PACK BELLOWS

New clamp PN NSA5532C612

SB 21-1155 planned for Sep-05
- *AIR CONDITIONING*
  INSTALL IMPROVED CLAMP ON BELLOWS AT PACK OUTLET AND BETWEEN PACK OUTLET CHECK VALVE AND MIXER UNIT

Modification 35038
Embodiment Rank MSN 2538

Proposal 3
ATA 21-50-00 - CONDENSER

New condenser PN 756A0000-06

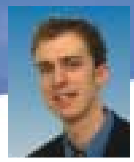
VSB 756A-21-04 Rev. 00 15 - Feb 05
- *AIR CONDITIONING*
  STRENGTH IMPROVEMENT OF SIDE PLATE

TFU 21.52.32.003

ATA 27 - FLIGHT CONTROLS

ATA 27
Flight controls

Joan Rendu
Engineer Flight Control Systems
Customer Services Engineering

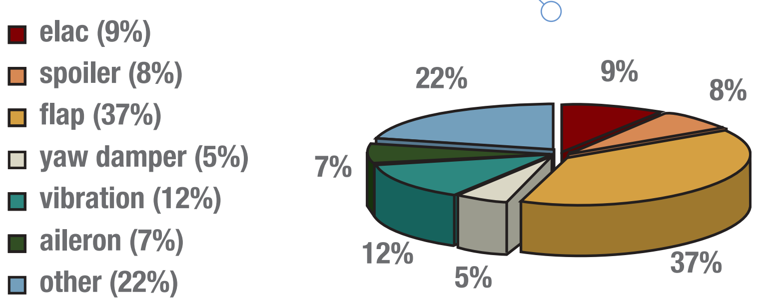


In 2004, 6% of all in-flight interruptions have been attributed to ATA chapter 27. Constributors are multiple but, as the chart shows, the two most significant are flaps and vibration.

The flap category represents the biggest contributor to operational interruptions with 37% of the total for flight controls. This includes faults that range from single SFCC (Slat and Flap Control Computer) faults with no effect on flap and slat availability, to faults that lead to flap/slat lock. Flap or slat lock has a direct impact on landing distance (defined in the Flight Crew Operating Manual).

Vibration is the second most significant operational interruption contributor with 12%. It should be noted that vibration has no effect on handling or performance efficiency: concerned surfaces and systems remain fully efficient during vibration events.

ATA 27 distribution
(129 events Jan. 01 - Sept. 04)



Proposal 1
FLAP ROTARY ACTUATOR

There are 4 rotary actuators on each wing. The function of these actuators is to translate the rotary motion of the flap drive shaft into movement of the flaps.

Further to flap lock events, it was reported in several cases that the flap rotary actuators had recently been removed for re-greasing.

Investigation revealed that during accomplishment of removal or installation of the flap rotary actuators a slight mis-rigging in the flap transmission had been induced. This was found as a contributing factor in the reported flap locks.

Flap rotary actuator

Flap rotary actuators filled with grease pre mod 28898 or pre mod 28899 need removal for re-greasing approximately every 5 years (Refer to MPD task 275449-05-1). A new type of actuator post mod 28898 or 28899 (post SB 27-1138) embodied since MSN 1256 are filled with semi fluid and are serviceable on wing. This eases maintenance and avoids removal/installation of the actuators.

+ Reduced maintenance

- Need to replace greased actuator with semi-fluid one

Proposal 2
VIBRATION

Airbus has adressed the majority of airframe vibration sources. However, vibration related events can still occur and comprehensive advice for addressing them effectively is provided in the Trouble Shooting Manual (TSM).

When the aircraft is on ground it is difficult for maintenance to identify the vibration source.

Effective troubleshooting of in flight vibration avoids vibration reoccurrence and associated potential operational interruptions.

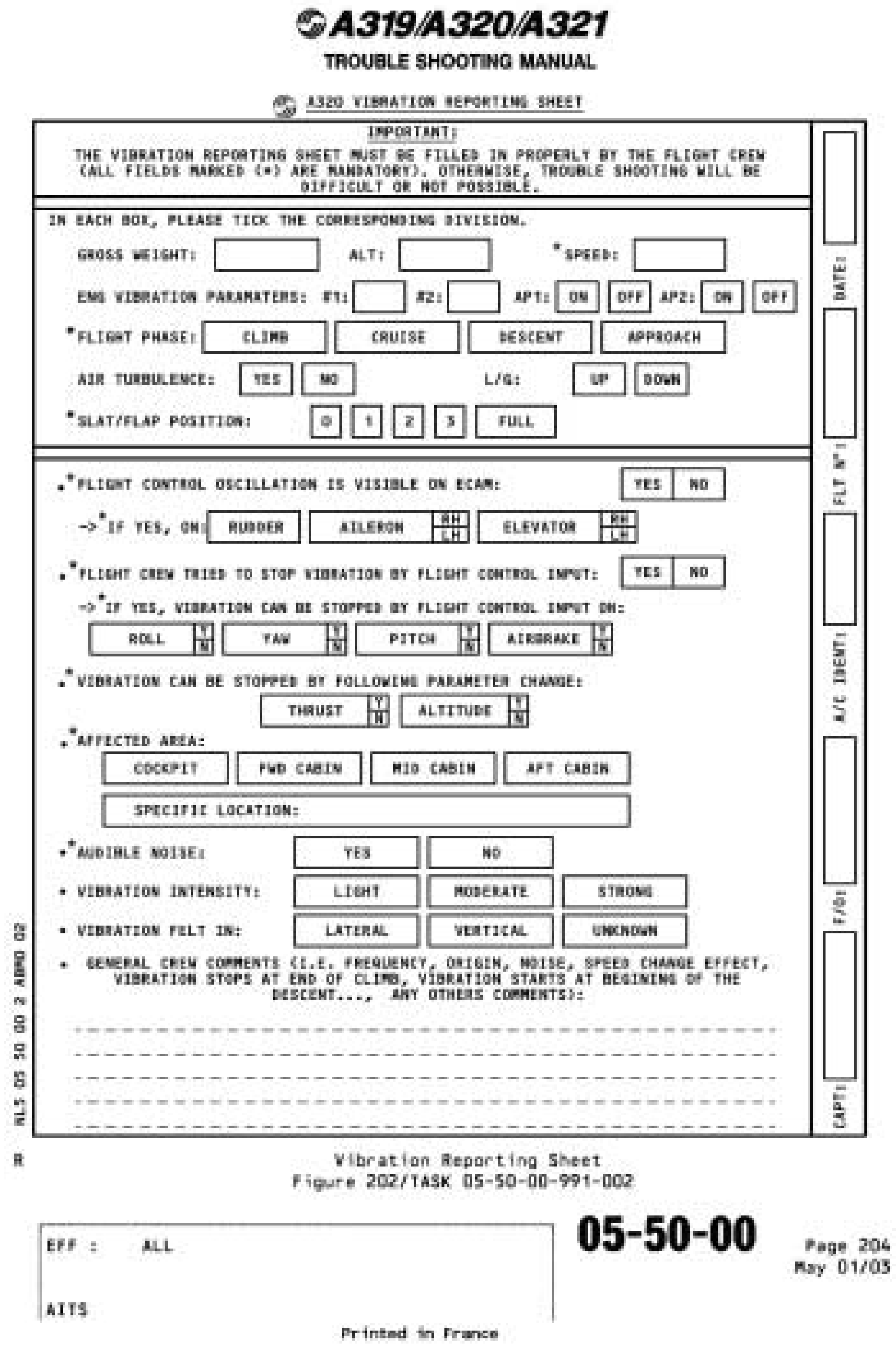
Rapid and efficient troubleshooting requires accurate pilot reporting using the vibration reporting sheet (entry point for TSM task 05-50-00-810-801).

It is important to note that for optimum troubleshooting efficiency, the flight crew should attempt to isolate the vibration source during flight by modifying the flight parameters (e.g. pitch, yaw, speed, etc.).

+ Minimum cost, improves communication between flight crew and maintenance

- None

Note that the vibration reporting sheet also allows isolation of vibration/noise from any source (e.g. flight controls, belly fairing seals, engines, doors etc).



A319/A320/A321
TROUBLE SHOOTING MANUAL

A320 VIBRATION REPORTING SHEET

IMPORTANT:
THE VIBRATION REPORTING SHEET MUST BE FILLED IN PROPERLY BY THE FLIGHT CREW (ALL FIELDS MARKED (*) ARE MANDATORY). OTHERWISE, TROUBLE SHOOTING WILL BE DIFFICULT OR NOT POSSIBLE.

IN EACH BOX, PLEASE TICK THE CORRESPONDING DIVISION.

GROSS WEIGHT: ____ ALT: ____ *SPEED: ____
ENG VIBRATION PARAMATERS: #1: ____ #2: ____ AP1: ON OFF AP2: ON OFF
*FLIGHT PHASE: CLIMB CRUISE DESCENT APPROACH
AIR TURBULENCE: YES NO L/G: UP DOWN
*SLAT/FLAP POSITION: 0 1 2 3 FULL

- *FLIGHT CONTROL OSCILLATION IS VISIBLE ON ECAM: YES NO
  - -> *IF YES, ON: RUDDER AILERON RH/LH ELEVATOR RH/LH
- *FLIGHT CREW TRIED TO STOP VIBRATION BY FLIGHT CONTROL INPUT: YES NO
  - -> *IF YES, VIBRATION CAN BE STOPPED BY FLIGHT CONTROL INPUT ON: ROLL Y/N YAW Y/N PITCH Y/N AIRBRAKE Y/N
- *VIBRATION CAN BE STOPPED BY FOLLOWING PARAMETER CHANGE: THRUST Y/N ALTITUDE Y/N
- *AFFECTED AREA: COCKPIT FWD CABIN MID CABIN AFT CABIN
  SPECIFIC LOCATION:
- *AUDIBLE NOISE: YES NO
- VIBRATION INTENSITY: LIGHT MODERATE STRONG
- VIBRATION FELT IN: LATERAL VERTICAL UNKNOWN
- GENERAL CREW COMMENTS (I.E. FREQUENCY, ORIGIN, NOISE, SPEED CHANGE EFFECT, VIBRATION STOPS AT END OF CLIMB, VIBRATION STARTS AT BEGINING OF THE DESCENT..., ANY OTHERS COMMENTS):

DATE: FLT N°: A/C IDENT: F/O: CAPT:

RLS 05 50 00 2 ABMD 02

R

Vibration Reporting Sheet
Figure 202/TASK 05-50-00-991-002

EFF : ALL

AITS

05-50-00

Page 204
May 01/03

Printed in France

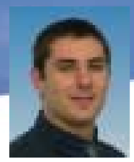
Contact

Joan Rendu
Engineer Flight Control Systems
Customer Services Engineering
Tel: +33 (0)5 62 11 01 42
Fax: + 33 (0)5 61 93 44 25
joan.rendu@airbus.com

ATA 29 - HYDRAULIC SYSTEM

ATA 29
Hydraulic system

Cédric Turroque
Engineer Hydraulic Systems
Customer Services Engineering



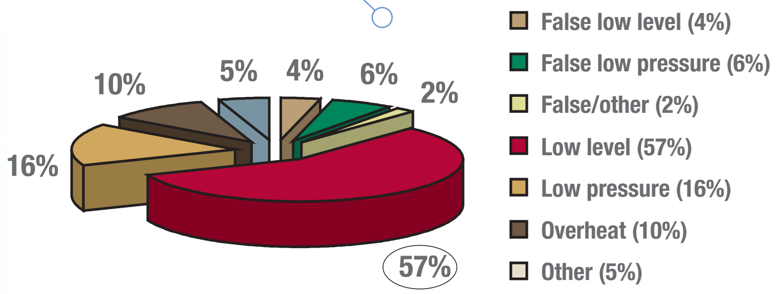
A hydraulic system is usually considered lost when one of the following cockpit messages is triggered: fluid quantity loss, fluid/pump overheat or air/hydraulic low pressure (or overpressure in a few cases). These can either be the result of a spurious/false fault message, or generated by a confirmed system failure.

Hydraulic system loss alone does not necessarily lead to in-flight interruption, as some operators (crews), in this situation, can choose to continue the flight or not.

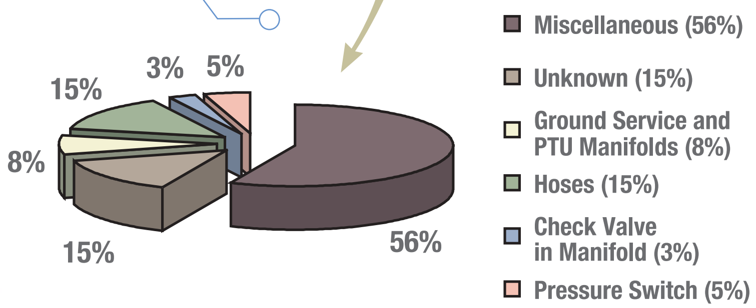
In 2004, 9% of in-flight interruptions were attributable to ATA 29. For our review, we have divided the causes into two main categories:

- Interruptions due to hydraulic system malfunctions (i.e. false fault messages, overheat, low pressure, etc.). These represent approximately 40% of the total in-flight interruptions for ATA29.
- Interruptions due to hydraulic leakages, which account for the remaining 60%.

ATA 29 distribution



Main leak drivers for the 57% low level items



Proposal 1
FLEXIBLE HOSE INSPECTION

Flexible hoses are installed in the hydraulic distribution system where movement is required and to ease removal/installation of components. Pressure fluctuations, pulsations of the system and bending cycles impose a high level of stress in the hose. In addition, some flexible hoses are subject to difficult environmental conditions, such as temperature variation, foreign object damage, or chemical attacks (carbon burst, de-icing fluid etc.). If not replaced, damage to a hose or its wire braid, can lead to hydraulic leakage, and possibly system loss. Although flexible hoses are 'on condition' parts, Airbus recommends to carry out visual inspections of these flexible hoses, and more particularly those in specific and sensitive areas, such as the landing gear, landing gear doors, flight controls and the hydraulic bay.

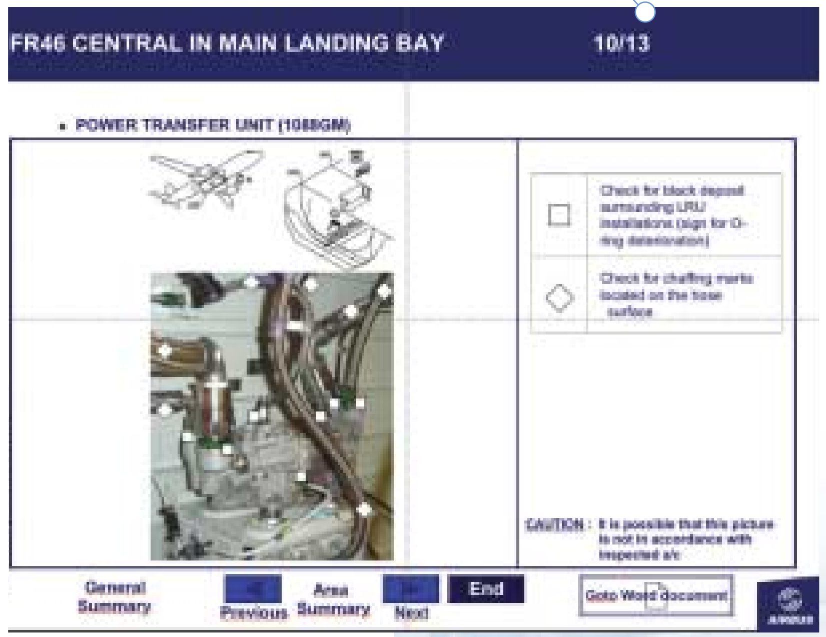
During such an inspection, the installation of the line must be checked (routing, clearances, clamp position/integrity), as well as the integrity of the flexible hoses themselves (see rejection criteria in the following paragraph).

Wire-braided hoses/conduits have to be replaced when:

- Two or more wires in one plait or several wires are broken in a concentrated area
- 10% or more of a given braided area exhibits wear from chafing
- Braid is protected by a neoprene overlay and wear or chafing into the braid has occurred.

To ease the operator's integration of such visual inspection in their scheduled maintenance programmes, Airbus has developed a CD-Rom, called 'Hydraulic Systems – Visual Inspection Guide'. It covers all the areas and equipment that could be checked and has been developed in conjunction with operators of the A320 Family.

Example of an illustration displayed on the 'Visual inspection Guide' CD-Rom



+ Can be done during aircraft maintenance check

- Additional maintenance

Proposal 2
HYDRAULIC PRESSURE SWITCHES

Two types of pressure switch are installed on A320 Family aircraft:

- Engine pressure switches, located at the outlet port of both Green and Yellow Engine Driven Pumps (EDPs)
- And manifold pressure switches, located on the High Pressure (HP) Manifolds (Green, Yellow and Blue systems), as well as at the outlet port of the Blue Electric Motor Pump (EMP).

Both types of switches have the same general design, the main difference being the warning threshold value, which is higher for the engine switch.

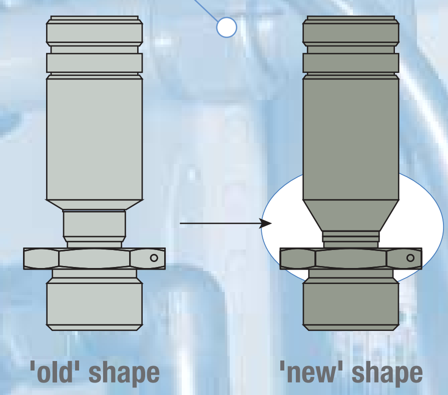
As shown in the main leak drivers pie chart, the pressure switches currently installed can give some spurious low-pressure messages. In addition, hydraulic leakage from the switch itself was reported in past years. It is estimated that overall pressure switch failures have led to 8.4% (for ATA 29) of the in-flight interruptions since 2001.

It has therefore been decided to develop an enhanced design for both pressure switch types to cure these issues. For this purpose:

- PN 450-1-3100-00 will replace PN 50-1-3100-00 on the EDP outlet ports
- PN 450-2-3100-00 will replace PN 50-2-3100-00 on the manifolds and EMP outlet ports.

These units are still under the validation process and will be available for procurement mid-2005.

Pressure Switch shape change



Documentation

Proposal 2
HYDRAULIC PRESSURE SWITCHES
- Airbus Service Bulletin 29-1096: 'INSTALL MODIFIED "EDP" SENSE LINE ON V2500 ENGINES'
- TFU 29.11.17.001: 'EDP PRESS SWITCH FAILURE ON IAE V2500 ENGINE'
- TFU 29.30.00.008: 'HYDRAULIC PRESSURE SWITCH LOW RELIABILITY'

For further information on their availability and to follow up Airbus actions, please refer to TFU 29.30.00.008.

Please also refer to closed TFU 29.11.17.001 (EDP Pressure Switch failure on IAE Engines), which introduces a new pressure switch installation on IAE Engines through Airbus SB 29-1096 and IAE SB V2500-NAC-0263.

+ Prevents spurious message and leakage

- None

Proposal 3 GROUND SERVICE AND POWER TRANSFER UNIT (PTU) MANIFOLDS

Ground Service Manifold PN S4-3500272 is originally installed on aircraft pre-mod 25159 (MSN<632).

The Power Transfer Unit Manifold PN D2907019000200/400/600 are originally installed on aircraft pre-mod 27490 (MSN before 972).

The investigations carried out on several returned units of the above PNs have led Airbus to publish some recommendations, detailed in SIL 29-080, that describe the preventive replacement of these manifolds.

PTU and Ground Service Manifolds leakages represent 19% of in-flight interruptions due to hydraulic leakage for aircraft prior to MSN 972.

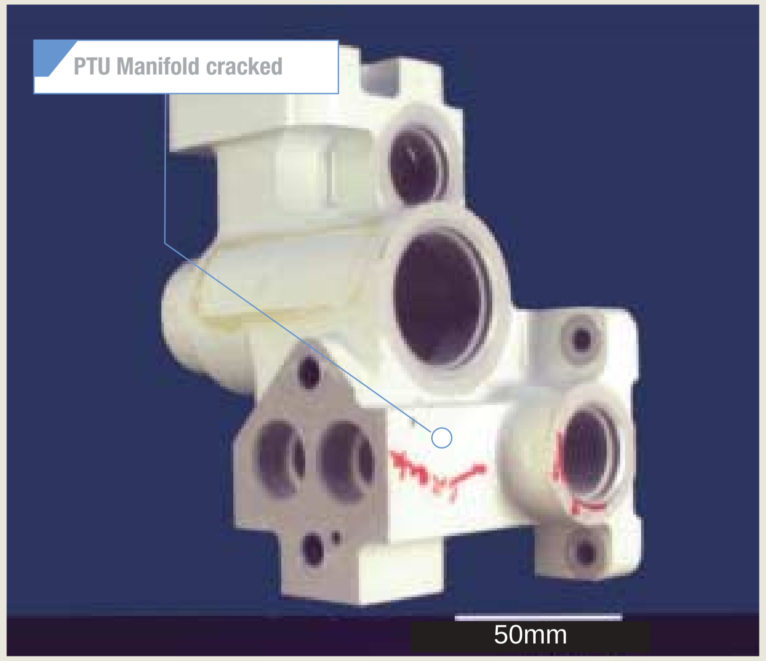
GROUND SERVICE MANIFOLD PRE-MOD 25159

Airbus recommends that pre-mod 25159 Green and Blue Ground Service Manifolds, PN S4-3500272, are replaced by post-mod 25159 Manifolds, PN S4-3500711, S4-3500712 or PN S4-350071L before reaching 19,000 flight cycles (refer to SIL 29-077).

PTU MANIFOLD PRE-MOD 27490

Airbus recommends that the pre-mod 27490 Yellow PTU manifolds are replaced before reaching 15,000 flight cycles:

- Either by the same model PN D2907019000X00 with further replacements scheduled within 15,000 flight cycles
- Or by an improved PTU manifold PN 1556A9900-01 that has demonstrated enhanced fatigue endurance properties, by embodying SB A320-29-1113. This requires some modifications to the plumbing installation surrounding the manifold.



Documentation

Proposal 3
GROUND SERVICE AND POWER TRANSFER UNIT MANIFOLDS

- Airbus Service Bulletin 29-1113: 'INTRODUCE LIEBHERR PTU MANIFOLD'
- Airbus Service Information Letter 29-077: 'INTRODUCTION OF IMPROVED GROUND SERVICE MANIFOLD (GSM) IN THE GREEN (FIN 1146GM) AND BLUE (2146GM) HYDRAULIC SYSTEMS FOR PRE-MOD 25159 AIRCRAFT'
- Airbus Service Information Letter 29-080: 'RECOMMENDATIONS FOR PREVENTIVE REPLACEMENT OF THE YELLOW PTU MANIFOLD AND THE GREEN AND BLUE GROUND SERVICE MANIFOLDS'
- TFU 29.19.00.001: 'YELLOW SYSTEM GROUND SERVICE MANIFOLD FAILURE'
- TFU 29.13.15.001: 'YELLOW SYSTEM – PTU MANIFOLD BODY CRACKS"

ATA 29 - HYDRAULIC SYSTEM

+ Reduces leakage

- Scheduled replacement

Proposal 4 CHECK-VALVES IN HP/PTU MANIFOLD

Check-Valves PN ZCV66 and ZCV67 are located in the HP and PTU Manifold pre-mod 27490, i.e. before MSN 972 (FINs 1059GM, 1094GM, 2059GM, 3059GM & 3094GM).

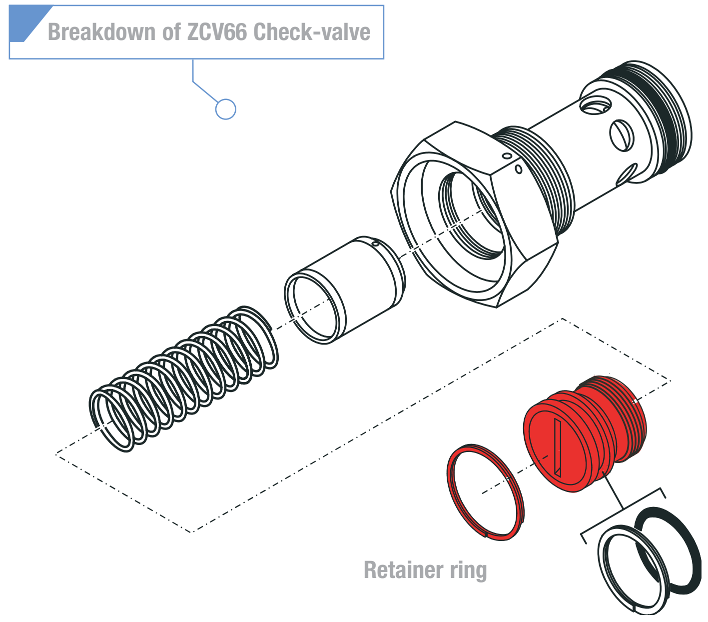
Further to several operator reports of hydraulic leakage from check-valve ZCV66 / ZCV67, Airbus has launched investigations to determine the root cause. Each time, it was found that a retainer ring was missing on the leaking units, leading to the cap loosening and subsequent O-ring damage.

Two solutions are available to operators:

- The preferred solution is to install a new check-valve, PN ZCV66-1/ZCV67-1, by Airbus SB 29-1107 (covering Circle Seal Controls SB ZCV66-29-1 & ZCV67-29-1)
- Otherwise, inspect, as per SB 29-1109, the already installed check-valves and verify that the retainer rings are correctly fitted. If not, VSB ZCV66-29-2/ZCV67-29-2 must be carried out to replace and safety (Loctite) the retainer ring.

+ Two solutions available
Ease of implementation

- None



Documentation

Proposal 4
CHECK-VALVES IN HP/PTU MANIFOLD

- Airbus Service Bulletin 29-1107: 'INSTALL MODIFIED CHECK-VALVES'
- Airbus Service Bulletin 29-1109: 'CHECK AND RE-INSTALL RETAINER RING ON CHECK-VALVE PN ZCV66/67'

Contact

Cédric Turroque
Engineer Hydraulic Systems
Customer Services Engineering
Tel: +33 (0)5 62 11 82 51
Fax : +33 (0)5 61 93 32 73
cedric.c.turroque@airbus.com

ATA 32
Landing gear systems

Jérôme Lesage
Engineer A380 & A320 Family Landing gear
Customer Services Engineering

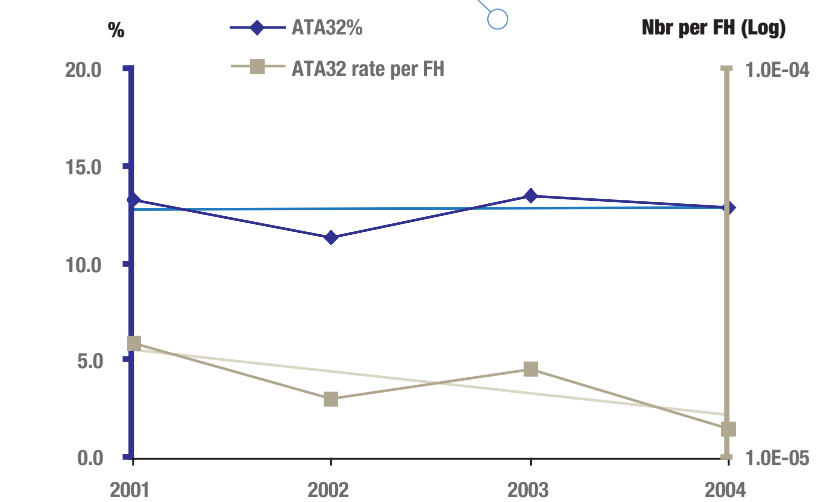
Landing gear non-retraction during take-off phase is a key factor in in-flight interruptions. It represents roughly 14% of fleet reports. Although significant decrease in rate has been demonstrated on ATA 32, the large number of equipments involved in the landing gear extension/retraction sequence still gives a remote, but wide, spread of failure modes.

The proposals given provide simple and proven advice to significantly reduce ATA 32 related flight interruptions.

The first one, related to ground lock pins and ground lock sleeves, commonly called ‘safety devices’, or ‘safety pins’, may appear obvious. However, the increase of flight interruptions reported due to safety devices forgotten on the landing gear prior to take off, combined with an increase of queries on the subject led us to make known Airbus operator experiences.

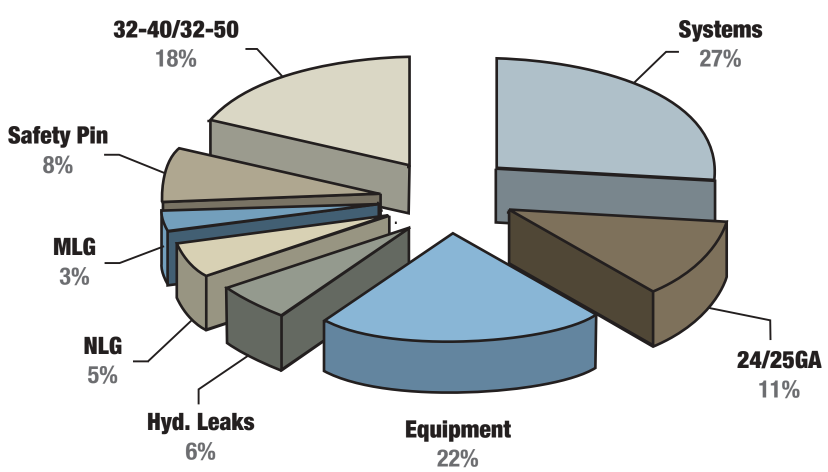
The other one relates to the nose landing gear (NLG) ‘flight/ground’ indication system. This item aims to address improvements and thus to correct one of the main contributing factors to landing gear retraction failure.

ATA 32 IFTB number per FH and %



ATA 32 distribution

Two ATA32 key contributing factors have been identified.



Proposal 1
GROUND LOCK SAFETY DEVICES

Installation of the landing gear safety devices (ground lock pins and collars), when the aircraft is towed or pushed-back during flight operation is optional. Airbus do not intend to make recommendations to favour one way or the other as some airlines require installation of ground lock pins and collars, whereas some do not want to do this.

The rationale behind this optional statement is that during the A320 Family operation, green hydraulic power supply is generally ON, giving two different means to physically achieve the landing gear down and locked position:

- Gear architecture (nose landing gear over-centred position and downlock springs),
- Green power supply at the downlock actuators.

However, under towing operation for maintenance, when the hydraulic power supply is not available, one downlock means is removed. Under such circumstances, Airbus recommends usage of the ground lock pins and collars which are 100% reliable to ensure physical downlocking of the landing gear.

With regard to the above, Airbus would like to highlight the following:

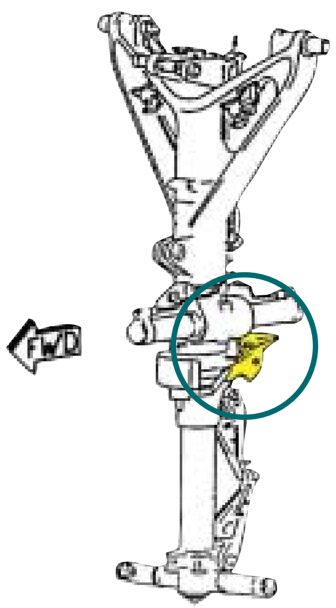
- Installation of the devices is optional. It is not a requirement for operational pushback (i.e. during turnaround)
- The devices are made visible (with a red flag for the pins) to the ground crew. It remains the operator’s responsibility to check they do not hang underneath the aircraft prior to departure
- It remains the airline’s maintenance staff responsibility to ensure the red paint/flags are in good condition

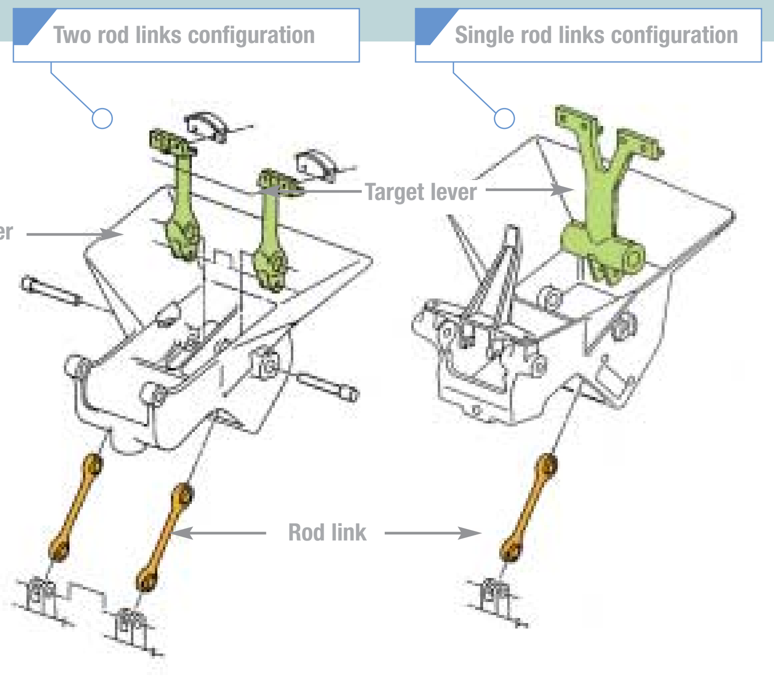
Landing gear safety devices: ground lock pins and collars

- Some airlines who fit ground lock pins and collars during turnaround have particular check-lists requesting their flight crew to ask ground crew to show, in their hands, removed pins and collars prior to final dispatch. This may be an effective way to avoid interruptions, if you wish to install those pins during short turn arounds.

+ Ease of implementation
Low cost

- None





Proposal 2
NOSE LANDING GEAR 'FLIGHT/GROUND' INDICATING SYSTEM

The NLG 'flight/ground' indicating system consists of a mechanical mechanism driving two sensors (FIN 24GA and 25GA) see figure above. It indicates whether the aircraft is 'in flight' and 'straight' (shock absorber extended and centred) or 'on ground' (shock absorber compressed or not 'straight').

Three failure modes have been identified that induce bending or fatigue break of the sensors 24/25GA rod links, which can lead to flight interruptions:

- Looseness of the NLG cover
- Seizure/jamming of the rod links
- Corrosion/seizure of the target lever eye end bearings.

The following modifications have been defined to address these failure modes:

- Cover fastening reinforcement (Messier-Dowty -Vendor Service Bulletin 580-32-3133)
- Rod links reinforcement (Messier-Dowty -Vendor Service Bulletin 580-32-3157)
- Target lever modification to add a greasing path and then allow its lubrication (Messier-Dowty -Vendor- Service Bulletin 580-32-3155).

Both Vendor Service Bulletin 580-32-3155 and 580-32-3157 are covered by Airbus Service Bulletin A320-32-1288.

Pending embodiment of these modifications, some maintenance may be applied to prevent the failure mode of the rod eye end and target lever axle (refer to TFU 32-21-11-012): *'Cleaning of the interface rod link axle as well as the target lever axle. If the target lever or the axles are removed, ensure the axle lever torque value is between 4 and 5nm (2.949 to 3.687lbf)'.*

\+ Long term effectiveness
Cost effective

\- One grease point added to the NLG.

Contact

Jérôme Lesage
Engineer A380 & A320 Family
Landing gear
Customer Services Engineering
Tel: +33 (0)5 62 11 86 11
Fax : +33 (0)5 61 93 32 73
jerome.lesage@airbus.com

Modification point of embodiment in production (MSN)

	A320 (Std 1)	A321 (Std 2)	A319 (Std 3)	A318 (Std 4)
VSB 580-32-3133	856	864	860	1660
SB A320-32-1288	2336	2363	2355	2358

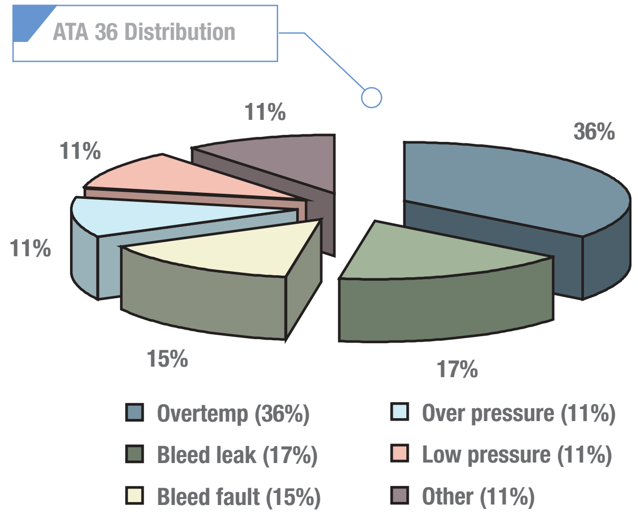
ATA 36
Engine bleed air system

Patrick Grave
Pneumatics, Ice and Fire Protection
Customer Services Engineering

During 2004, 8% of all in-flight interruptions have been attributed to ATA chapter 36. Analysis of these interrruptions clearly shows that the main causes are either bleed air duct leak detection or bleed air over-temperature regulation (leading to single or double bleed loss). These two main reasons are driving more than 60% of ATA chapter 36 interruptions.

The main contributors to these failure modes are well identified and have fixes already available:

- Temperature Control Thermostat (TCT) failure is one major contributor to the over-temperature regulation (either TCT failure or TCT filter clogging)
- Bleed air duct seal leakage for bleed air leaks.



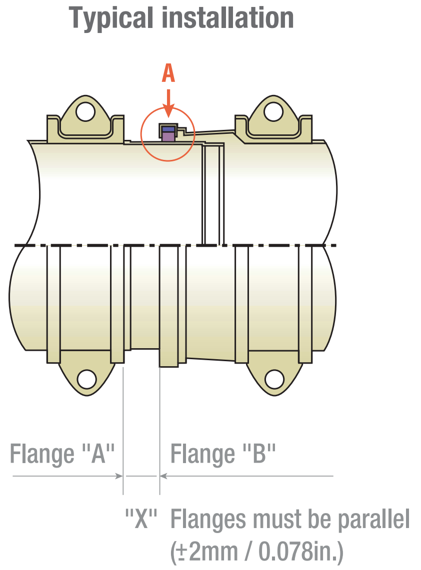
Proposal 1
BLEED AIR DUCTS LEAKS

Investigation revealed that bleed air ducts leaks represent 17% of in-flight interruptions. For this type of failure mode there are two possible solutions.

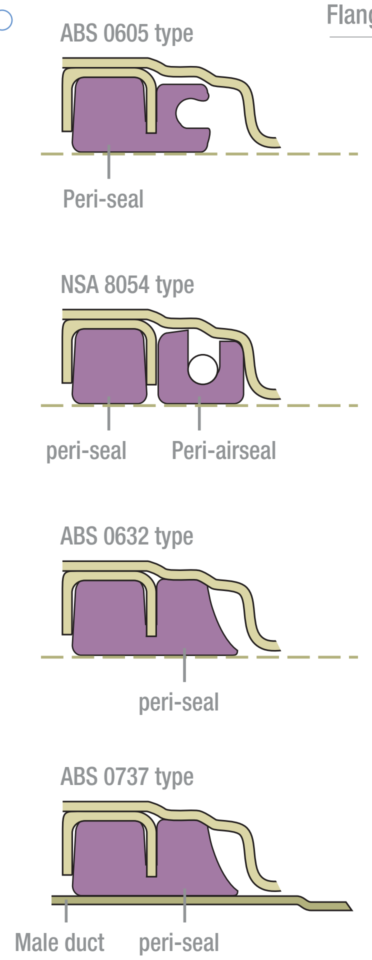
The first solution (considered as a preventive action) is the application of the MPD tasks for preventive seals replacement (ABS0737 considered as the best reliable seal from previous design). These recommendations are also described in SIL 36-047.

The new technology developed for the bleed air duct seals is also available for the air conditioning packs through SB A320-21-1153 (available second quarter of 2005). It should be noted that bleed air leaks in the pack bay will trigger a wing leak warning and as such contribute to ATA36 reliability performance.

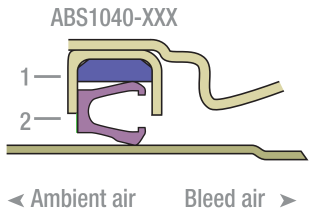
Bleed air duct seal installation



Previous seals designs



New seal design



The second solution offers a far greater service life and is considered the final fix. It incorporates a new design of bleed air duct seal, ABS1040, and is available through SB A320-36-1043 (Modification 32027, Embodiment rank MSN 1830).

+ Ease of implementation
Low cost

- None

Proposal 2
BLEED OVER-TEMPERATURE DUE TO TCT FAILURE

Part of 51% of in flight interruptions (combined bleed fault and over-temperature). For information: bleed fault warnings can be due to either an over-temperature or an over-pressure. From experience, it is considered that a large part of bleed faults are due over-temperature and consequently linked to TCT behaviour.

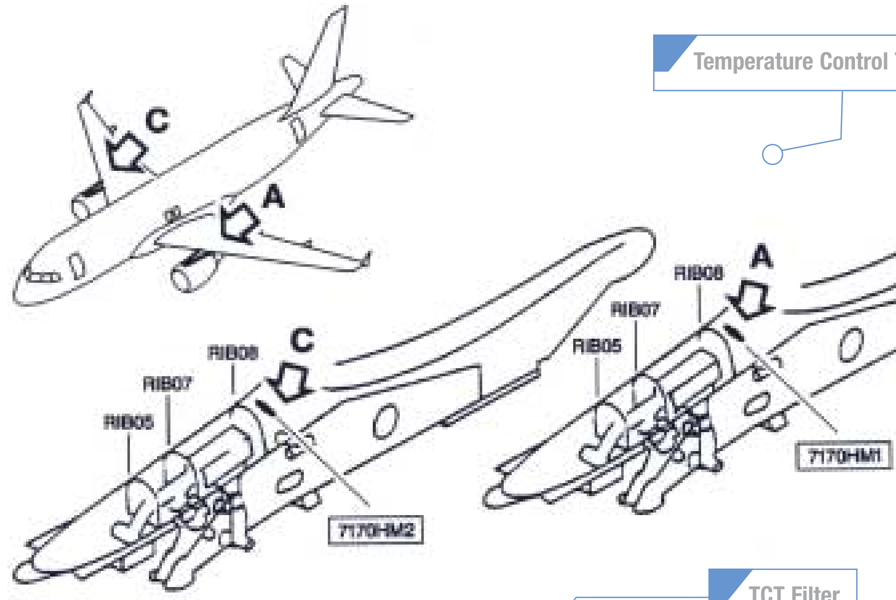
The type of failure is known to be due to a particular TCT Part Number (PN). An improved PN is available to address this issue and application of a one-time TCT inspection, as per SB A320-36-1049, will allow the TCT PN to be identified and replaced if required.

+ Ease of implementation
Low cost

- None

Examples of TCT clogged filters

Temperature Control Thermostat (TCT) Location



Proposal 3
BLEED OVER-TEMPERATURE DUE TO TCT FILTER CONTAMINATION

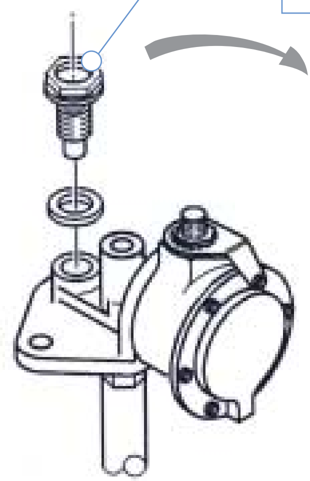
Part of 51% of in flight interruptions (combined bleed fault and over-temperature).

Another well known possibility for bleed air over-temperature is the TCT filter clogging. To address this issue regular filter cleaning is recommended and is available through the application of the corresponding MPD task. Today's recommended interval is 20 months. Nevertheless, depending on operating environment and operator's experience, a less or a more frequent initial interval may be used. For example, it has been well established that Middle East operators were more affected than others. This recommendation is also described in SIL 36-055.

+ Ease of implementation
Low cost

- None

TCT Filter

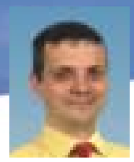


Contact

Patrick Grave
Pneumatics, Ice and Fire Protection
Group Manager
Customer Services Engineering
Tel: +33 (0)5 61 93 43 13
Fax : +33 (0)5 61 93 44 38
patrick.grave@airbus.com

ATA 52
Doors

Arnaud Blanc-Nikolaïtchouk
Structure Engineer Support
Customer Services Engineering



Overall, for the year 2004, 6% of in-flight interruptions were attributed to ATA chapter 52.

As far as doors are concerned, cargo door false open warnings were identified as the main contributor to reported in-flight interruptions or rejected take off. In addition, analysis shows that, in most cases identified preventive actions could have avoided these events.

In all cases, doors were confirmed closed and locked afterwards.

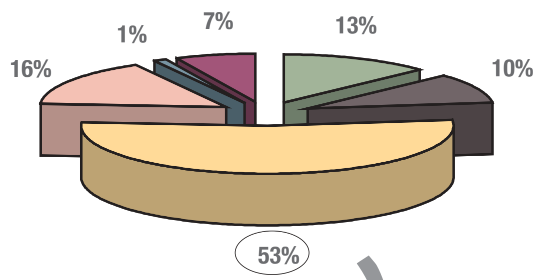
Since the introduction of a new standard of cargo door handle mechanism, the number of events has been drastically reduced.

The major causes identified are:

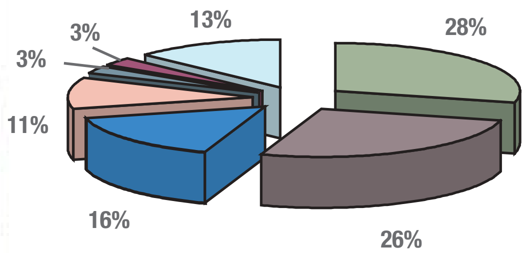
- Cargo door handle deformed or cracked (old standard)
- Partial embodiment of SB A320-52-1039 (old standard)
- Proximity switch 28WV/34WV or 30WV/32WV
- Handle hook mechanism jammed (old standard)

More detailed information on these issues is provided in SIL 52-055. Trouble shooting information is given in Trouble Shooting Manual 52-31-00.

ATA 52 Distribution



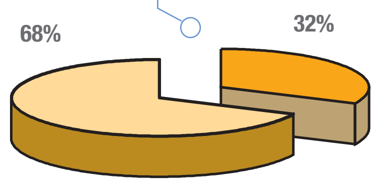
Cargo door distribution



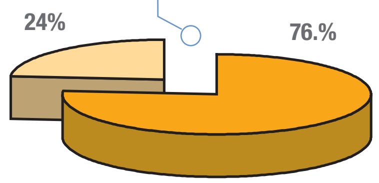
Two types of cargo door handle can be found on A319/A320/A321 aircraft. Mod 26213 introduced a new cargo door improved design, starting with MSN 759. From this MSN, a completely new design of handle was introduced.

Although two thirds of aircraft in service at the end of 2004 are fitted with the new cargo door standard, reports on 'old standard' handles represent more than 75% of the cases as you can see on the pie chart on the following page.

Old/new handle distribution



Old/new handle Events distribution



Proposal 1
CARGO DOOR HANDLE

On pre-mod 26213 (old design) aircraft, the cargo door handle can be deformed or cracked due to overloading or impact damage. In these cases, the proximity switch 28WV/34WV that monitors the position of the handle can generate a warning.

This issue was initially addressed by mod 23213 that introduces a reinforced handle on MSN 455, 471, 513 to 516, 524 and subsequent (SB A320-52-1039).

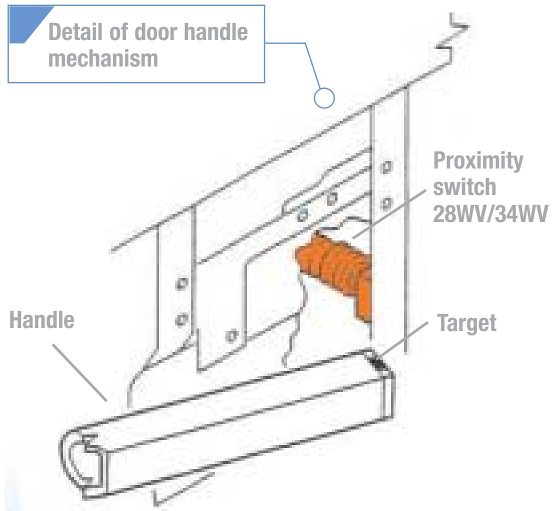
Cases were reported where a reinforced handle is installed on a pre-mod 23213 aircraft as a replacement without full embodiment of SB A320-52-1039. This SB consists of installing a reinforced handle and handle fitting, and reworking the handle mechanism. If a post-mod handle is installed on a pre-mod aircraft without the mechanism rework, interference may occur causing the handle to move out of its recess, resulting in a warning being generated.

It is recommended to **fully** embody SB A320-52-1039 on pre-mod 23213 aircraft. TFU 52.30.00.002 also contains details on this point.

+ Long term effectiveness

- None

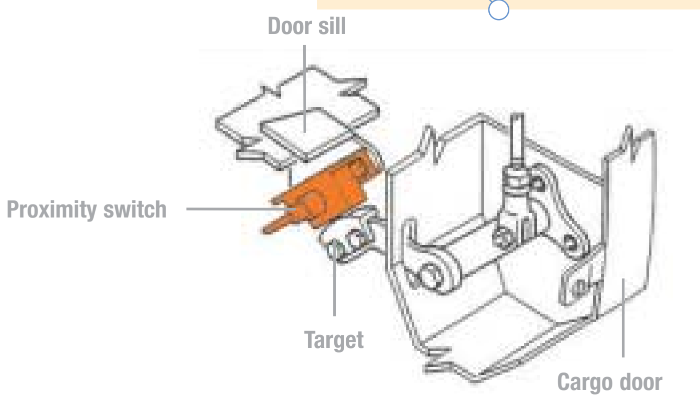
Detail of door handle mechanism

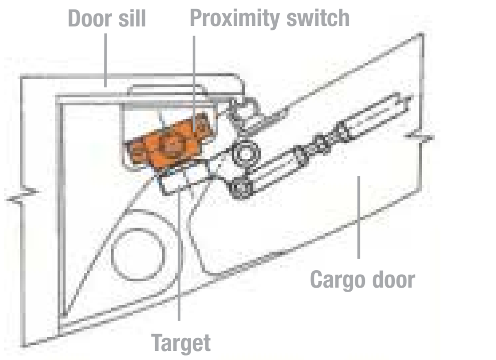


Old standard door handle from MSN001

New standard door handle from production aircraft

Proximity switch 30WV/32WV





Proposal 2
PROXIMITY SWITCH 28WV /34WV or 30WV/32WV

The proximity switches 28WV /34WV and/or 30WV/32WV can become incorrectly adjusted or faulty. AMM procedure 52-71-00 describes the cargo door proximity switch adjustment procedures.

As a preventive action, some operators have introduced a proximity switch adjustment check, as per AMM 52-71-00, every C-check.

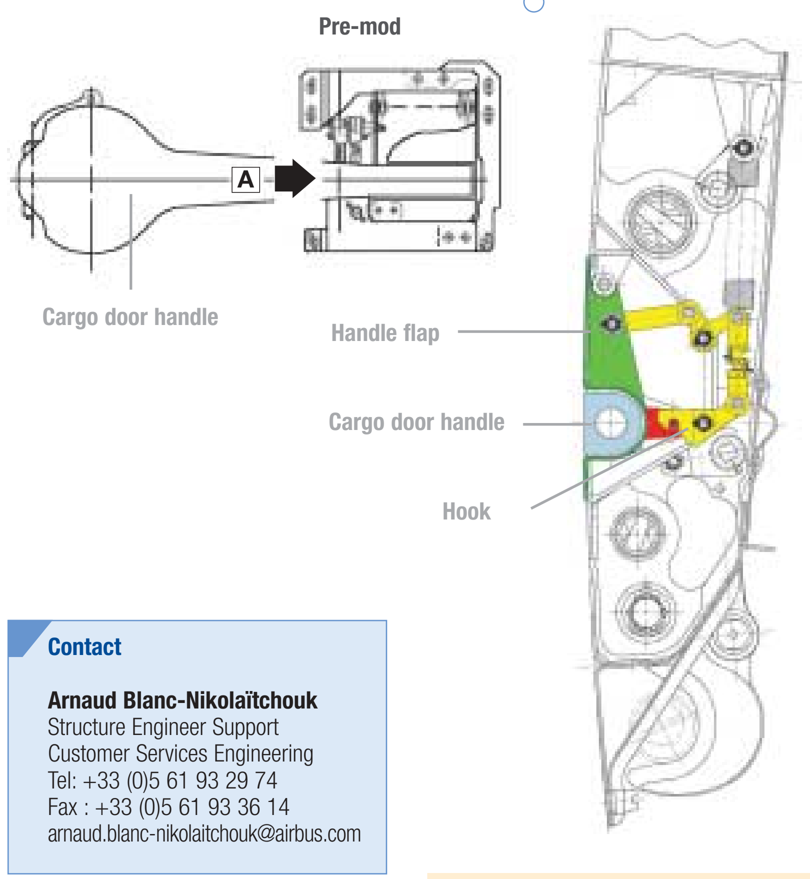
Introduction of an all metal sensor PN 8-933-01 improved the reliability of the sensors. The new all metal sensor is fully interchangeable with the previous standard and is now the preferred spare part.

Inductance check of the proximity sensors is covered by AMM task 32-31-73 and allows their condition to be assessed.

+ Cheap and simple

- None

Handle hook mechanism



Proposal 3
HANDLE HOOK MECHANISM

Cases of the handle hook mechanism (IPC 52-31-21) being stiff or jammed have been found. In these cases, the hook does not engage correctly on the handle. Should such a situation occur, the handle flap will not be flush with the door outer skin contour and generate a warning.

It is recommended to clean/lubricate the handle locking linkage every C-check as per MPD 523000-03-1 and AMM task 12-22-52-640-009.

+ Easy to implement

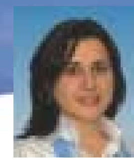
- None

Contact

Arnaud Blanc-Nikolaïtchouk
Structure Engineer Support
Customer Services Engineering
Tel: +33 (0)5 61 93 29 74
Fax : +33 (0)5 61 93 36 14
arnaud.blanc-nikolaitchouk@airbus.com

ATA 70-80
Propulsion system

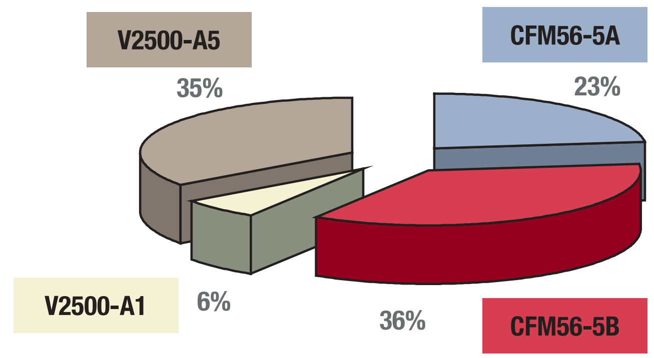
Raquel Sanchez-Garcia
A320 Family Propulsion System Engineer
Customer Services Engineering



Over the last four years the number of events attributed to the Propulsion System has regularly decreased. In 2004, 14% of in-flight interruptions were attributed to the ATA chapters concerned (ATA 70 to 80). During these four years, well over 900 aircraft have been delivered (a fleet growth of amost 70%).

These events were reviewed for each of the propulsion systems employed in the A320 Family (breakdown shown in the pie-chart) to identify the main contributors and proposals are provided accordingly.

ATA 70-80 distribution



The review of each propulsion system reveals two common contributors to in-flight interruptions, which are Exhaust Gas Temperature (EGT) and vibration.

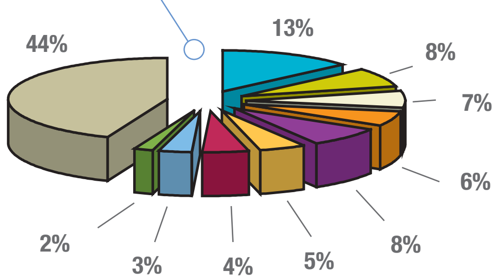
Several causes were identified, amongst them bird strike and EGT overlimit are the most numerous. Whereas bird strikes are hard to prevent, some EGT driven events may be avoided through close trend monitoring.

Generic proposals

The first generic proposal is to implement an engine trend monitoring system. Low EGT margin conditions, as well as possible drift in engine behaviour can be monitored and actions initiated before possible events occur.
Secondly, in order to monitor fleet reliability and follow related engine reliability initiatives, we suggest contacting Airbus Customer Services Powerplant or your engine representative.

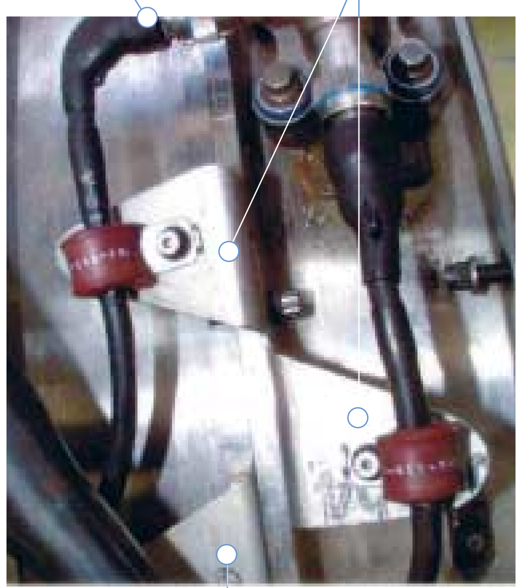
More engine information is also available on:
• www.cfm56.com
• www.iae4u.com

CFM56-5B in-flight interruptions ATA 70-80 (98 events Jan 01 - Sep 04)

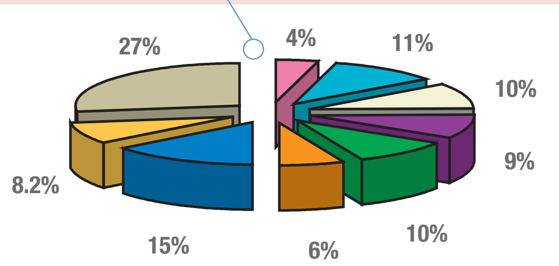


- Vibration
- N1 Fluctuations
- EGT
- Smoke
- Compressor vane
- Oil pressure
- Oil leak
- Oil quantity loss
- Oil filter
- Surge
- Reverser
- FADEC
- Others

Current bracket (aluminium alloy) & new bracket (stainless steel



CFM56-5A in-flight interruptions ATA 70-80



CFM56-5A & 5B ENGINES

For CFM56-5A engines during the last four years Full Authority Digital Electronic Control (FADEC) faults are the biggest contributor to in-flight interruptions (14.6%). Normally, this includes faults in the Electronic Control Unit system (ECU).

Vibration is the second biggest contributor with 10.8%. In the majority of cases this is attributed to Low Pressure Turbine (LPT) and High Pressure Compressor (HPC) blade Foreign Object Damage (FOD).

For CFM56-5B during the last four years vibration (13%), N1 (Low Pressure System Speed) fluctuations (8%) and compressor vane (8%) faults are the biggest contributors to in-flight interruptions. The event causes are the T12 temperature sensor and the air system Variable Bleed Valve (VBV).

Proposal 1
N1 fluctuations
T12 sensor temperature
CFM56-5B

The dual T12 temperature sensor measures the engine inlet total air temperature and the ECU in the engine power management logic uses this temperature value. The T12 dual temperature sensor is installed on the fan inlet cowl and is connected to the ECU by branches of the harness HJ8 and HJ10.

Investigation has shown that vibration can cause the wiring harness and T12 sensor connectors to wear heavily. Connector wear generates particle liberation and contamination and degrades the T12 sensor signal.

Engineering testing on-engine has confirmed the need for harness bracket modification.

A new bracket (see illustration on the left) will be added to better support the harnesses and the current bracket, made of aluminium alloy, will be replaced by a stainless steel one. The modifications may be done on wing and a Service Bulletin and kit will be available from the second quarter of 2005.

+ Ease of implementation
Low cost

- None

Proposal 2
Compressor vane
Air System VBV Stop Mechanism
CFM56-5A & CFM56-5B

A numbers of events were reported to be due to seized VBV stop mechanism. Investigation revealed that a defined population of units were assembled with insufficient quantity of lubricant. The following corrective actions have been implemented:

- Production assembly manual revised (Apr 04)
- Component Maintenance Manual 75-31-22 TR 75-05 (Oct 04) issued
- Affected population identification: 1867 parts are affected
- CFM Service Bulletin SB75-0062 (5A), & SB75-0030 (5B) to improve VBV System reliability. Mobil 28 grease is introduced in the VBV ballscrew actuators, replacing the Tribolube 2 grease. These SBs will be issued second quarter 2005.

+ Ease of implementation
Minimum cost

- None

ATA 70-80 - PROPULSION SYSTEM

V2500-A1 & A5 ENGINE

For V2500-A1, EGT and vibration are the biggest contributors to in-flight interruptions with 27% and 13.4% respectively. With the exception of foreign object related damage the evolution in these parameters can be monitored with a trend monitoring system (see Generic Proposals on page 21).

For V2500-A5, EGT and engine stalls are the biggest contributors with 20% and 16% respectively.

Regarding stall events, two main drivers were identified:

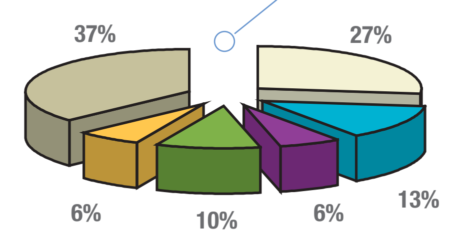
- HP Compressor 6: Fleet Management Plan completed successfully (IAE NMSB 72-0445 - Airbus SB 72-1023)
- Variable Stator Vane system (VSV).

Proposal 1
Compressor Vane VSV
V2500-A5

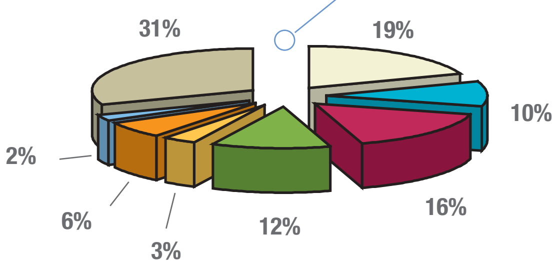
Several cases of transitory 'ENG COMPRESSOR VANE' warnings have been reported at Take Off (TO) to Climb (CLB) thrust transition, on hot days, on recently delivered aircraft, with no impact observed on main engine parameters. In these circumstances, the warning is associated with 'CHA(B) VSV ACT/HC/EEC1(2)' failure message in the Post Flight Report, and 'SVATK' in FADEC troubleshooting data. This issue was initially identified on engines below 2500 flight hours since new, when the outside air temperature was more than 30°C. However, deeper understanding proved that the issue is more linked to flight cycles (FC) than flight hours and that:

- Occurrence rate should drastically decrease after 1,500FC,
- Occurrence rate should drastically decrease below 25°C.

V2500-A1 IFTB and DV ATA 70-80 (56 events Jan 01 - Sep 04)



V2500-A5 IFTB and DV (142 events Jan 01 - Sep 04)



INTERIM MEASURES

Although VSV actuator replacement and/or VSV system lubrication may reduce the occurrence rate of the events, these actions are not expected to fully clear the issue. Since warnings occurring in the above conditions have no impact on engine parameters, no specific maintenance is required when this issue is experienced. Until recently, such alleviation of maintenance action had to be covered on a case by case basis via IAE One Time Concession (OTC). The Airbus TSM was updated to cover this for the Nov 04 revision to reduce the maintenance burden.

CORRECTIVE ACTIONS

IAE has identified an area of marginality in fuel servo pressure versus required VSV load at certain ambient conditions and engine power change conditions. Further investigation eventually led IAE to review the following possible software fixes for this issue:

- Improvement of TO to CLB engine deceleration schedule, or
- Refinement of fault triggering conditions, or
- Improvement of VSV control schedule

Three possible FADEC software changes are currently being evaluated by IAE. One of these changes, or a combination of these changes will be incorporated in FADEC software SCN19 that is scheduled for the beginning of 2006.

+ Ease of implementation
Low cost

- None

- EGT
- Vibration
- Compressor vane
- Engine stall and Compressor vane
- EPR
- Oil pressure
- Oil clog
- Oil quantity loss
- Others

Contact

Raquel Sanchez-Garcia
Propulsion System Engineer
Customer Services Engineering
Tel: +33 (0)5 61 93 25 53
Fax : +33 (0)5 93 44 38
raquel.sanchez-garcia@airbus.com

Conclusion

As this FAST Special has explained, an in-flight interruption is a rare event and, for the A320 Family, the rate continues to fall. Nonetheless, these events are unquestionably significant for any aircraft operator.

The ongoing process of identifying reliability drivers continues. Airbus and its vendors will also continue to offer new enhancements as needs and opportunities appear.

The current fleet of the A320 Family is operated by approximately 150 different organizations. Today, on average, an aircraft of the A320 Family experiences an in-flight interruption approximately once every 7000 flights. For an operator of six aircraft with average utilisation this suggests one in-flight interruption event every four or five months.

For this FAST Special, analysis of the events recorded during the last four years has been carried out. This has allowed proposals that will be applicable to the greatest number of operators to be identified. However, as might be expected for a mature aircraft family, the root causes are widely spread. Nonetheless, some proposals stand out as having a wide applicability and offer a significant contribution to further in-flight interruption reduction. In addition, most proposals offer an intrinsic improvement in overall system reliability that should not be forgotten when considering their implementation.

The recently available standard V06 of the **Avionic Equipment Ventilation Computer,** (AEVC), described on page 4, addresses a number of issues that have been at the root of a relatively high percentage of in-flight interruptions.

Similarly, the **Temperature Control Thermostat** (TCT), described on page 17, has also been identified as being the cause of a relatively high number of events, particularly when operating in dusty environments.

Other proposals that are considered to be of particular interest are:

- **Nose Landing Gear Ground/Flight Indicating System** (page 14)
- **Bleed Air Duct seals** (page 15 and 16)
- **Air Conditioning Pack Bellows clamps** (page 5)
- **Air Conditioning Pack Condenser reinforcement** (page 5)
- **Hydraulic Hose inspection** (page 8 and 9)

Implementation of any one of the proposals in this FAST Special applicable to your airline and its fleet will reduce the number of in-flight interruptions.

Should there be any questions concerning the contents of this document please do not hesitate to contact the author of the relevant ATA chapter, your Regional Customer Services Manager (RCSM) or your Customer Services Director (CSD).

GUIDE TO CHARTS

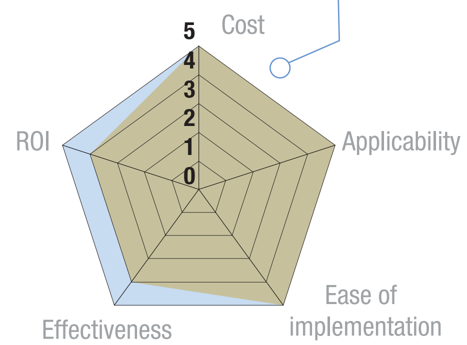
A graphical assessment is provided for those proposals with a particularly wide interest.

There is one chart for each proposal and each assesses the relative merits of each proposal against the five criteria as follows:

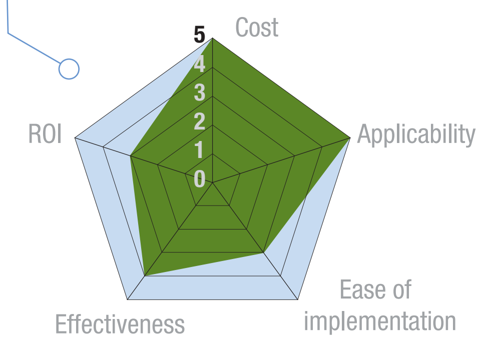
• Cost	5 = Low	1 = High
• Applicability	5 = Wide	1 = Limited
• Ease of implementation	5 = Easy	1 = Complex
• Effectiveness	5 = High	1 = Low
• ROI (Return On Investment)	5 = Short period	1 = Long term

In short, the greater the area covered the higher the overall interest.

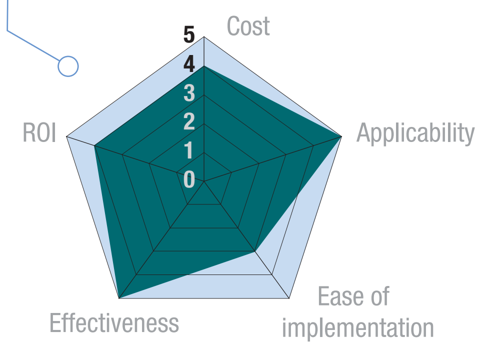
Hydraulic distribution System Hose inspection



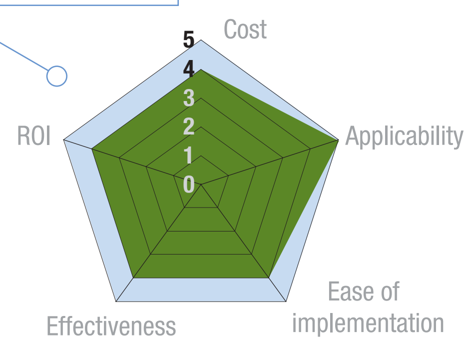
Air conditioning Pack bellow clamps



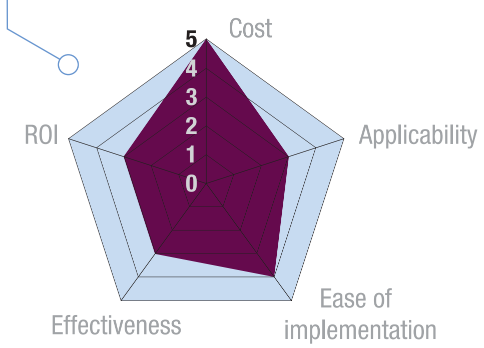
Nose Landing Gear Flight/Ground indicating system



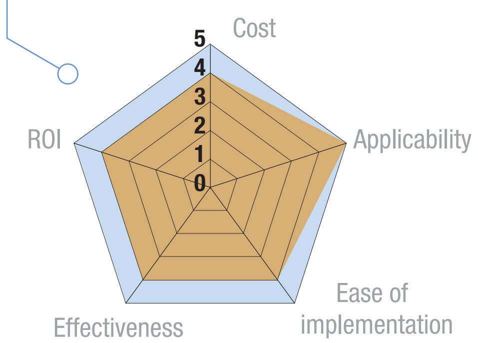
Air conditioning Pack Condenser reinforcement



Bleed air duct seals



AEVC V06



Temperature Control Thermostat